

What is claimed is:

1. A method for automatically teaching a reference position which is the reference of the position of a disc-like object in the reference co-ordinate system including the position of a handling device to the handling device of the fore-mentioned disc-like object, comprising a step of determining the center position of a disc-like object with a known radius which was situated at a fixed place being the reference position in the fore-mentioned reference co-ordinate system and a step of memorizing the position of the fore-mentioned fixed place in the fore-mentioned reference co-ordinate system which was determined by calculation based on the fore-mentioned center position in the fore-mentioned handling device as the reference position,

wherein the step of determining the center position of the fore-mentioned disc-like object comprises a step of relatively moving a detection means against the fore-mentioned disc-like object and making one locus of the fore-mentioned detection means cross against the circumference of the fore-mentioned disc-like object,

a step of determining the position of two intersections by the fore-mentioned crossing in the fore-mentioned reference co-ordinate system, and

a step of calculating the fore-mentioned center position using the specific point on the perpendicular bisector of the section of a line combining the fore-mentioned two intersections, the fore-mentioned two intersections and the radius of the fore-mentioned disc-like object.

2. An automatic reference position teaching method of a disc-like object according to Claim 1, wherein the locus of the fore-mentioned detection means is a circular arc.

3. A method for automatically positioning a disc-like object with a known radius in the reference co-ordinate system including the position of a handling device of the fore-mentioned disc-like object, comprising a step of determining the center position of the fore-mentioned disc-like object in the fore-mentioned reference co-ordinate system and

a step of calculating a transition quantity from the center position preliminarily taught to the fore-mentioned center position determined in the fore-mentioned reference co-ordinate system,

wherein the step of determining the center position of the fore-mentioned disc-like object comprises a step of relatively moving a detection means against the fore-mentioned disc-like object and making one locus of the fore-mentioned detection means cross against the circumference of the fore-mentioned disc-like object,

a step of determining the position of two intersections by the fore-mentioned crossing in the fore-mentioned reference co-ordinate system, and

a step of calculating the fore-mentioned center position using the specific point on the perpendicular bisector of the section of a line combining the fore-mentioned two intersections, the fore-mentioned two intersections and the radius of the fore-mentioned disc-like object.

4. A method for automatically positioning a disc-like object with a known radius having one concave portion or one convex portion at one portion of peripheral rim in the reference co-ordinate system including the position of a handling device of the disc-like object, comprising a step of determining the center position of the fore-mentioned disc-like object having a concave portion or a convex portion in the fore-mentioned reference co-ordinate system and a step of calculating a transition quantity from the center position preliminarily taught to the fore-mentioned center position determined in the fore-mentioned reference co-ordinate system,

wherein the step of determining the center position of the fore-mentioned disc-like object having a concave portion or a convex portion comprises a step of relatively moving a detection means against the fore-mentioned disc-like object and making two loci of the fore-mentioned detection means cross against the peripheral rim of the fore-mentioned disc-like object,

a step of determining the position of two pairs of intersections consisting of two points of each of the pairs by crossing of the fore-mentioned two loci with the peripheral rim of the fore-mentioned disc-like object in the fore-mentioned reference co-ordinate system,

a step of calculating the center position of a circle when those intersections are situated on a circumference including the fore-mentioned peripheral rim excluding the fore-mentioned concave portion or convex portion using the specific point on the perpendicular bisector of the section of a line combining the

fore-mentioned two intersections, the fore-mentioned two intersections and the radius of the fore-mentioned disc-like object, with respect to the fore-mentioned two pairs, and

a step of selecting the center position of the fore-mentioned disc-like object based on the positional deviation direction of the central point when the fore-mentioned intersections are situated at the fore-mentioned concave portion or convex portion comparing the fore-mentioned two center positions calculated.

5. An automatic positioning method of a disc-like object according to Claim 3 or 4, wherein the locus of the fore-mentioned detection means is a circular arc.

6. An automatic carrying method of a disc-like object, comprising a step of carrying out the automatic positioning method of the disc-like object according to any one of Claims 3 to 5,

a step of correcting a carrying route preliminarily taught of a holding portion of a carrying device as the fore-mentioned handling device based on a transition quantity which was calculated by the fore-mentioned positioning method, and

a step of carrying the fore-mentioned disc-like object to a fixed carrying position with the fore-mentioned holding portion of the fore-mentioned carrying device along the fore-mentioned carrying route corrected.

7. A device for automatically teaching a reference position which is the reference of the position of a disc-like object in the reference co-ordinate system including the position of a handling device to the handling device of the fore-mentioned disc-like object, equipped with a means of determining the center position of a disc-like object with a known radius which was situated at a fixed place being the reference position in the fore-mentioned reference co-ordinate system and a means of memorizing the position of the fore-mentioned fixed place in the fore-mentioned reference co-ordinate system which was determined by calculation based on the fore-mentioned center position in the fore-mentioned handling device as the reference position,

wherein the means of determining the center position of the fore-mentioned disc-like object has a means of relatively moving a detection means against the fore-mentioned disc-like object and making one locus of the fore-mentioned detection means cross against the circumference of the fore-mentioned disc-like object,

a means of determining the position of two intersections by the fore-mentioned crossing in the fore-mentioned reference co-ordinate system, and

a means of calculating the fore-mentioned center position using the specific point on the perpendicular bisector of the section of a line combining the fore-mentioned two intersections, the fore-mentioned two intersections and the radius of the fore-mentioned disc-like object.

8. An automatic reference position teaching device of a disc-like object according to Claim 7, wherein the locus of the fore-mentioned detection means is a circular arc.

9. A device for automatically positioning the fore-mentioned disc-like object with a known radius in the reference co-ordinate system including the position of a handling device of the disc-like object, equipped with a means of determining the center position of the fore-mentioned disc-like object in the fore-mentioned reference co-ordinate system and

a means of calculating a transition quantity from the center position preliminarily taught to the fore-mentioned center position determined in the fore-mentioned reference co-ordinate system,

wherein the means of determining the center position of the fore-mentioned disc-like object has a means of relatively moving a detection means against the fore-mentioned disc-like object and making one locus of the fore-mentioned detection means cross against the circumference of the fore-mentioned disc-like object,

a means of determining the position of two intersections by the fore-mentioned crossing in the fore-mentioned reference co-ordinate system, and

a means of calculating the fore-mentioned center position using the specific point on the perpendicular bisector of the section of a line combining the fore-mentioned two intersections, the fore-mentioned two intersections and the radius of the fore-mentioned disc-like object.

10. A device for automatically positioning a disc-like object with a known radius having one concave portion or one convex portion at one portion of peripheral rim in the reference co-ordinate system including the position of a handling device of the disc-like object, equipped with a means of determining the center position of the fore-mentioned disc-like object having a concave portion or a convex portion in the fore-mentioned reference co-ordinate system and a means

of calculating a transition quantity from the center position preliminarily taught to the fore-mentioned center position determined in the fore-mentioned reference co-ordinate system,

wherein the means of determining the center position of the fore-mentioned disc-like object having a concave portion or a convex portion has a means of relatively moving a detection means against the fore-mentioned disc-like object and making two loci of the fore-mentioned detection means cross against the peripheral rim of the fore-mentioned disc-like object,

a means of determining the position of two pairs of intersections consisting of two points of each of the pairs by crossing of the fore-mentioned two loci with the peripheral rim of the fore-mentioned disc-like object in the fore-mentioned reference co-ordinate system,

a means of calculating the center position of a circle when those intersections are situated on a circumference including the fore-mentioned peripheral rim excluding the fore-mentioned concave portion or convex portion using the specific point on the perpendicular bisector of the section of a line combining the fore-mentioned two intersections, the fore-mentioned two intersections and the radius of the fore-mentioned disc-like object, with respect to the fore-mentioned two pairs, and

a means of selecting the center position of the fore-mentioned disc-like object based on the positional deviation direction of the central point when the fore-mentioned intersections are situated at the fore-mentioned concave portion or convex portion comparing the fore-mentioned two center positions calculated.

11. An automatic positioning device of a disc-like object according to Claim 9 or 10, wherein the locus of the fore-mentioned detection means is a circular arc.

12. An automatic carrying device of a disc-like object, equipped with the automatic positioning device of a disc-like object according to any one of Claims 9 to 11,

a means of correcting a carrying route preliminarily taught of a holding portion of a carrying device as the fore-mentioned handling device based on a transition quantity which was calculated by the fore-mentioned positioning method, and

a means of carrying the fore-mentioned disc-like object to a fixed carrying position with the fore-mentioned holding portion along the fore-mentioned

carrying route corrected, by controlling the operation of the fore-mentioned holding portion of the fore-mentioned carrying device.

13. A method for automatically positioning a disc-like object with an unknown radius having one concave portion or one convex portion at one portion of peripheral rim in the reference co-ordinate system including the position of a handling device of the disc-like object, comprising a step of determining the center position of the fore-mentioned disc-like object having a concave portion or a convex portion in the fore-mentioned reference co-ordinate system and a step of calculating a transition quantity from the center position preliminarily taught to the fore-mentioned center position determined in the fore-mentioned reference co-ordinate system,

wherein the step of determining the center position of the fore-mentioned disc-like object having a concave portion or a convex portion comprises a step of relatively moving a detection means against the fore-mentioned disc-like object, making three loci of the fore-mentioned detection means cross against the peripheral rim of the fore-mentioned disc-like object and determining the position of 3 pairs of intersections consisting of one pair of 2 points in the fore-mentioned reference co-ordinate system,

a step of selecting a common perpendicular bisector among 3 perpendicular bisectors with respect to the intersections of the fore-mentioned 3 pairs, and

a step of calculating the radius of the fore-mentioned disc-like object and the center position from the specific point on the fore-mentioned common perpendicular bisector and 2 pairs of intersections with respect to the common perpendicular bisector.

14. An automatic positioning method of a disc-like object according to Claim 13, wherein the locus of the fore-mentioned detection means is a circular arc.

15. A device for automatically positioning a disc-like object with an unknown radius having one concave portion or one convex portion at one portion of peripheral rim in the reference co-ordinate system including the position of a handling device of the disc-like object, equipped with a means of determining the center position of the fore-mentioned disc-like object having a concave portion or a convex portion in the fore-mentioned reference co-ordinate system and a means of calculating a transition quantity from the center position preliminarily taught

to the fore-mentioned center position determined in the fore-mentioned reference co-ordinate system,

wherein the means of determining the center position of the fore-mentioned disc-like object having a concave portion or a convex portion has a means of relatively moving a detection means against the fore-mentioned disc-like object, making three loci of the fore-mentioned detection means cross against the peripheral rim of the fore-mentioned disc-like object and determining the position of 3 pairs of intersections consisting of one pair of 2 points in the fore-mentioned reference co-ordinate system,

a means of selecting a common perpendicular bisector among 3 perpendicular bisectors with respect to the intersections of the fore-mentioned 3 pairs, and

a means of calculating the radius of the fore-mentioned disc-like object and the center position from the specific point on the fore-mentioned common perpendicular bisector and 2 pairs of intersections with respect to the common perpendicular bisector.

16. An automatic positioning device of a disc-like object according to Claim 15, wherein the locus of the fore-mentioned detection means is a circular arc.

17. An automatic carrying device of a disc-like object with an unknown radius having one concave portion or one convex portion at one portion of peripheral rim, equipped with the automatic positioning device of a disc-like object according to Claim 15 or 16,

a correction means of correcting a carrying route preliminarily taught of a holding portion of a carrying device based on a transition quantity which was calculated by the fore-mentioned positioning method, and

a means of carrying the fore-mentioned disc-like object to a fixed carrying position with the fore-mentioned holding portion along the fore-mentioned carrying route corrected, by controlling the operation of the fore-mentioned holding portion of the fore-mentioned carrying device.

18. A method for automatically teaching a reference position which is the reference of the position of a disc-like object in the reference co-ordinate system including the position of a handling device of the fore-mentioned disc-like object, comprising a step of placing the disc-like object with an unknown radius at a fixed place which is the reference position,

a step of determining the center position of the fore-mentioned disc-like object in the fore-mentioned reference co-ordinate system and a step of memorizing the position of the fore-mentioned fixed place in the fore-mentioned reference co-ordinate system which was determined by calculation based on the fore-mentioned center position in the fore-mentioned handling device as the reference position,

wherein the step of determining the center position of the fore-mentioned disc-like object comprises

a step of detecting at least 3 points on the peripheral rim of the disc-like object by the relative movement of one one-point detecting type detection means against the fore-mentioned disc-like object, and

a step of determining the center position using at least 3 points of the fore-mentioned co-ordinate positions detected and the formula of a circumference.

19. An automatic teaching method of a disc-like object according to Claim 18, wherein in place of a step of detecting at least 3 points on the peripheral rim of the disc-like object by the relative movement of one one-point detecting type detection means, the fore-mentioned at least 3 points on the peripheral rim of the fore-mentioned disc-like object are detected by 3 or more of one-point detecting type detection means, and the fore-mentioned 3 or more of detection means comprise a step of detecting at least 3 points by respectively crossing once relatively against the peripheral rim of the fore-mentioned disc-like object.

20. An automatic teaching method of a disc-like object according to Claim 18 or 19, wherein the fore-mentioned detection means comprises a step of crossing with the peripheral rim of the fore-mentioned disc-like object by relatively drawing an O-character type, V-character type, U-character type, L-character type or C-character type locus against the fore-mentioned disc-like object.

21. An automatic teaching method of a disc-like object according to any one of Claims 18 to 20, wherein the fore-mentioned disc-like object is one with an unknown radius having one concave portion or one convex portion at one portion of peripheral rim, at least 3 points detected on the peripheral rim of the fore-mentioned disc-like object are 4 points or more, when all of the radii or center positions which were determined from the formula of a circumference coincide with respect to all of combinations which 3 points among the fore-mentioned 4



points or more constitute, the value is selected and when they do not coincide, the detection of the fore-mentioned 4 points or more are repeated until they coincide.

22. A method for automatically positioning the fore-mentioned disc-like object with an unknown radius in the reference co-ordinate system including the position of a handling device of the disc-like object, comprising a step of determining the center position of the fore-mentioned disc-like object in the fore-mentioned reference co-ordinate system and

a step of calculating a transition quantity from the center position preliminarily taught to the fore-mentioned center position determined in the fore-mentioned reference co-ordinate system,

wherein the step of determining the center position of the fore-mentioned disc-like object comprises a step of detecting at least 3 points on the peripheral rim of the disc-like object by the relative movement of one one-point detecting type detection means against the fore-mentioned disc-like object, and

a step of determining the center position using at least 3 points of the fore-mentioned co-ordinate positions detected and the formula of a circumference.

23. An automatic positioning method of a disc-like object according to Claim 22, wherein in place of a step of detecting at least 3 points on the peripheral rim of the disc-like object by the fore-mentioned one one-point detecting type detection means, the fore-mentioned at least 3 points on the peripheral rim of the fore-mentioned disc-like object are detected by 3 or more of one-point detecting type detection means, and the fore-mentioned 3 or more of detection means comprise a step of detecting at least 3 points by respectively crossing once relatively against the peripheral rim of the fore-mentioned disc-like object.

24. An automatic positioning method of a disc-like object according to Claim 22 or 23, wherein the fore-mentioned step of detecting at least 3 points comprises a step of crossing with the peripheral rim of the fore-mentioned disc-like object by relatively drawing an O-character type, V-character type, U-character type, L-character type or C-character type locus against the fore-mentioned disc-like object.

25. An automatic positioning method of a disc-like object according to any one of Claims 22 to 24, wherein the fore-mentioned disc-like object is one with an unknown radius having one concave portion or one convex portion at one portion

of peripheral rim, at least 3 points detected on the peripheral rim of the fore-mentioned disc-like object are 4 points or more, when all of the radii or center positions which were determined from the formula of a circumference coincide with respect to all of combinations which 3 points among the fore-mentioned 4 points or more constitute, the value is selected and when they do not coincide, the detection of the fore-mentioned 4 points or more are repeated until they coincide.

26. An automatic carrying method of a disc-like object using the automatic positioning method of the disc-like object according to any one of Claims 22 to 25, comprising

- a step of correcting a carrying route preliminarily taught of a holding portion of a carrying device as the fore-mentioned handling device based on a transition quantity which was calculated by the fore-mentioned positioning method, and

- a step of carrying the fore-mentioned disc-like object to a fixed carrying position with the fore-mentioned holding portion of the fore-mentioned carrying device along the fore-mentioned carrying route corrected.

27. A device for automatically teaching a reference position which is the reference of the position of a disc-like object in the reference co-ordinate system including the position of a handling device to the handling device of the fore-mentioned disc-like object, equipped with a means of determining the center position of a disc-like object with an unknown radius which was situated at a fixed place being the reference position in the fore-mentioned reference co-ordinate system and a means of memorizing the position of the fore-mentioned fixed place in the fore-mentioned reference co-ordinate system which was determined by calculation based on the fore-mentioned center position in the fore-mentioned handling device as the reference position,

wherein the means of determining the center position of the fore-mentioned disc-like object is equipped with

- a means of detecting at least 3 points on the peripheral rim of the disc-like object by the relative movement of one one-point detecting type detection means against the fore-mentioned disc-like object, and

- a means of determining the center position using at least 3 points of the fore-mentioned co-ordinate positions detected and the formula of a circumference.

28. An automatic teaching device of a disc-like object according to Claim 28,

wherein in place of a means of detecting at least 3 points on the peripheral rim of the disc-like object by the relative movement of one one-point detecting type detection means, the fore-mentioned at least 3 points on the peripheral rim of the fore-mentioned disc-like object are detected by 3 or more of one-point detecting type detection means, and the fore-mentioned 3 or more of detection means comprise a step of detecting at least 3 points by respectively crossing once relatively against the peripheral rim of the fore-mentioned disc-like object.

29. An automatic teaching device of a disc-like object according to Claim 27 or 28, wherein the fore-mentioned detection means crosses with the peripheral rim of the fore-mentioned disc-like object by relatively drawing an O-character type, V-character type, U-character type, L-character type or C-character type locus against the fore-mentioned disc-like object, in a means of detecting the fore-mentioned at least 3 points.

30. An automatic teaching device of a disc-like object according to any one of Claims 27 to 29, wherein the fore-mentioned disc-like object is one with an unknown radius having one concave portion or one convex portion at one portion of peripheral rim, the fore-mentioned at least 3 points detected on the peripheral rim of the fore-mentioned disc-like object are 4 points or more in a means of detecting the fore-mentioned at least 3 points, when all of the radii or center positions which were determined from the formula of a circumference coincide with respect to all of combinations which 3 points among the fore-mentioned 4 points or more constitute, the value is selected and when they do not coincide, the detection of the fore-mentioned 4 points or more are repeated until they coincide.

31. A device for automatically positioning the fore-mentioned disc-like object with an unknown radius in the reference co-ordinate system including the position of a handling device of the disc-like object, equipped with a means of determining the center position of the fore-mentioned disc-like object in the fore-mentioned reference co-ordinate system and

a means of calculating a transition quantity from the center position preliminarily taught to the fore-mentioned center position determined in the fore-mentioned reference co-ordinate system,

wherein the means of determining the center position of the fore-mentioned disc-like object comprises a means of detecting at least 3 points on the peripheral rim

of the disc-like object by the relative movement of one one-point detecting type detection means against the fore-mentioned disc-like object, and

a means of determining the center position using at least 3 points of the fore-mentioned co-ordinate positions detected and the formula of a circumference.

32. An automatic positioning device of a disc-like object according to Claim 31, wherein in place of a means of detecting at least 3 points on the peripheral rim of the disc-like object in the fore-mentioned one one-point detecting type detection means, a means of detecting at least 3 points on the peripheral rim of the fore-mentioned disc-like object by 3 or more of one-point detecting type detection means comprises a means of detecting at least 3 points by respectively crossing once relatively against the peripheral rim of the fore-mentioned disc-like object.

33. An automatic positioning device of a disc-like object according to Claim 31 or 32, wherein the fore-mentioned detection means crosses with the peripheral rim of the fore-mentioned disc-like object by relatively drawing an O-character type, V-character type, U-character type, L-character type or C-character type locus against the fore-mentioned disc-like object, in a means of detecting the fore-mentioned at least 3 points.

34. An automatic positioning device of a disc-like object according to any one of Claims 31 to 33, wherein the fore-mentioned disc-like object is one with an unknown radius having one concave portion or one convex portion at one portion of peripheral rim, the fore-mentioned at least 3 points detected on the peripheral rim of the fore-mentioned disc-like object are 4 points or more in a means of detecting the fore-mentioned at least 3 points, when all of the radii or center positions which were determined from the formula of a circumference coincide with respect to all of combinations which 3 points among the fore-mentioned 4 points or more constitute, the value is selected and when they do not coincide, the detection of the fore-mentioned 4 points or more are repeated until they coincide.

35. An automatic carrying device of a disc-like object using the automatic positioning device of the disc-like object according to any one of Claims 31 to 34, equipped with a means of correcting a carrying route preliminarily taught of a holding portion of a carrying device as the fore-mentioned handling device based on a transition quantity which was calculated by the fore-mentioned positioning method, and

a means of carrying the fore-mentioned disc-like object to a fixed carrying position with the fore-mentioned holding portion of the fore-mentioned carrying device along the fore-mentioned carrying route corrected.

36. An automatic semiconductor manufacturing equipment equipped with at least one of the automatic reference position teaching device of a disc-like object according to any one of Claims 7, 8 and 27 to 30, the automatic positioning device of a disc-like object according to any one of Claims 9 to 11, 15, 16 and 31 to 34, and the automatic carrying device of a disc-like object of a disc-like object according to any one of Claim 12, 17 or 35.